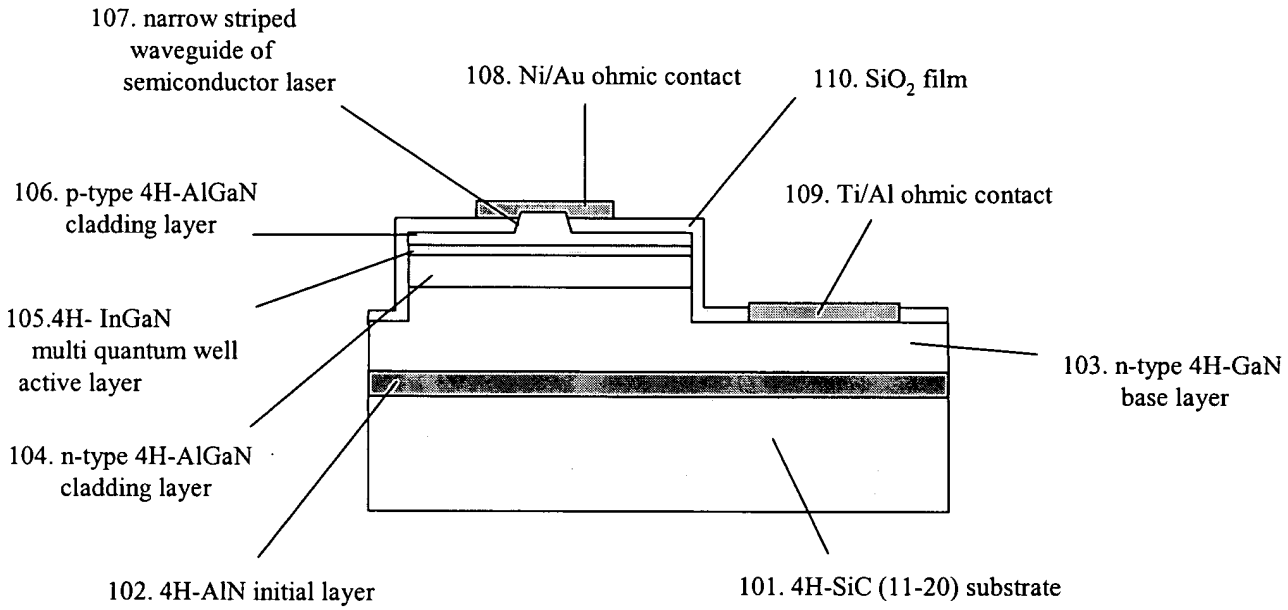


Fig. 1

Cross section of a III-V nitride-based blue-violet semiconductor laser with 4H-polytype on 4H-AlN/4H-SiC.
Cleaved facet to form the reflective mirror is on (0001) c-face.
substrate can be inclined to <1-100> direction.

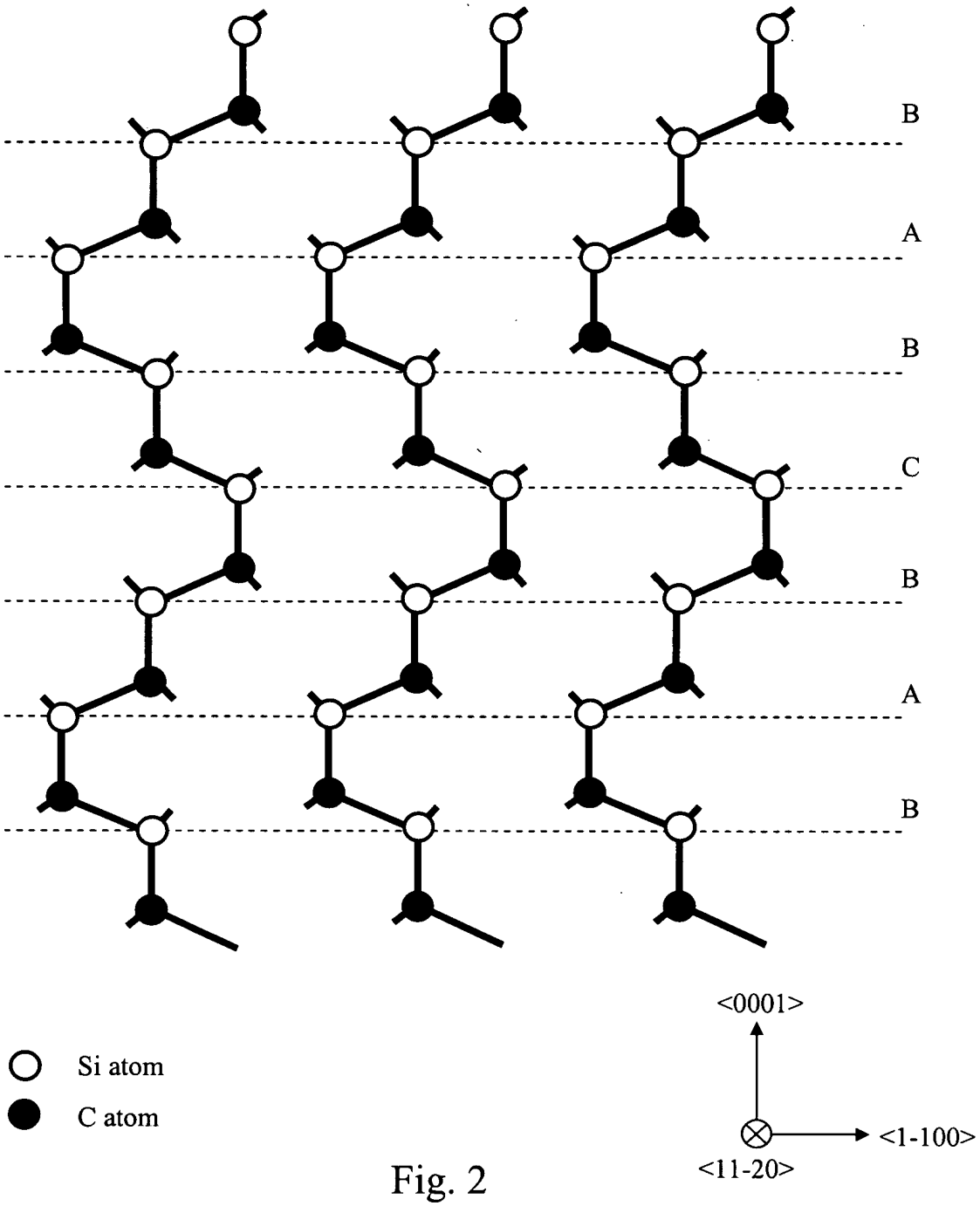


Fig. 2

Schematic drawing of atomic configuration on 4H-SiC (11-20) a-face.

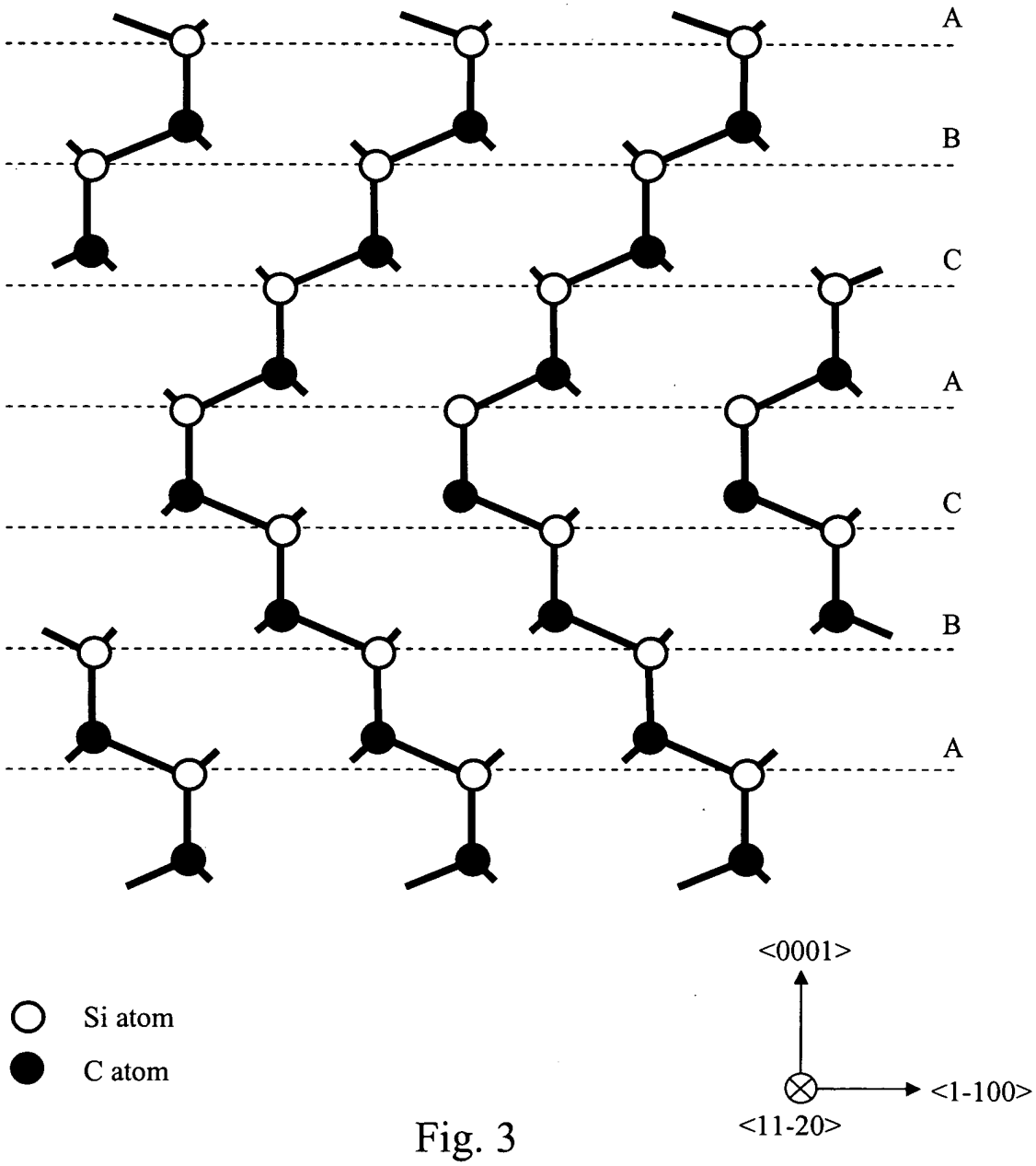


Fig. 3

Schematic drawing of atomic configuration on 6H-SiC (11-20) a-face.

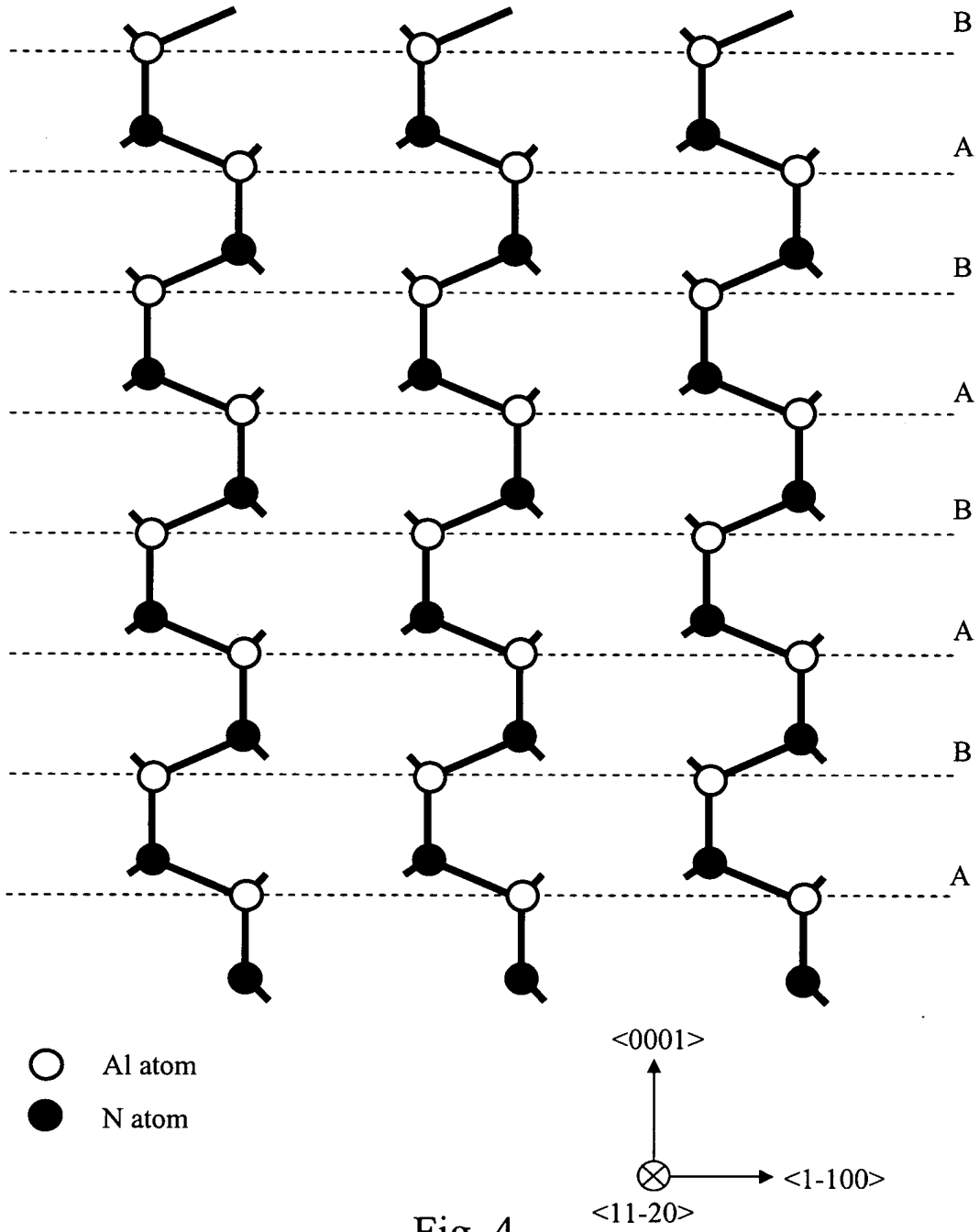


Fig. 4

Schematic drawing of atomic configuration on 2H-AlN (11-20) a-face.
All of the III-V nitride with 2H-polytype shows same configuration.

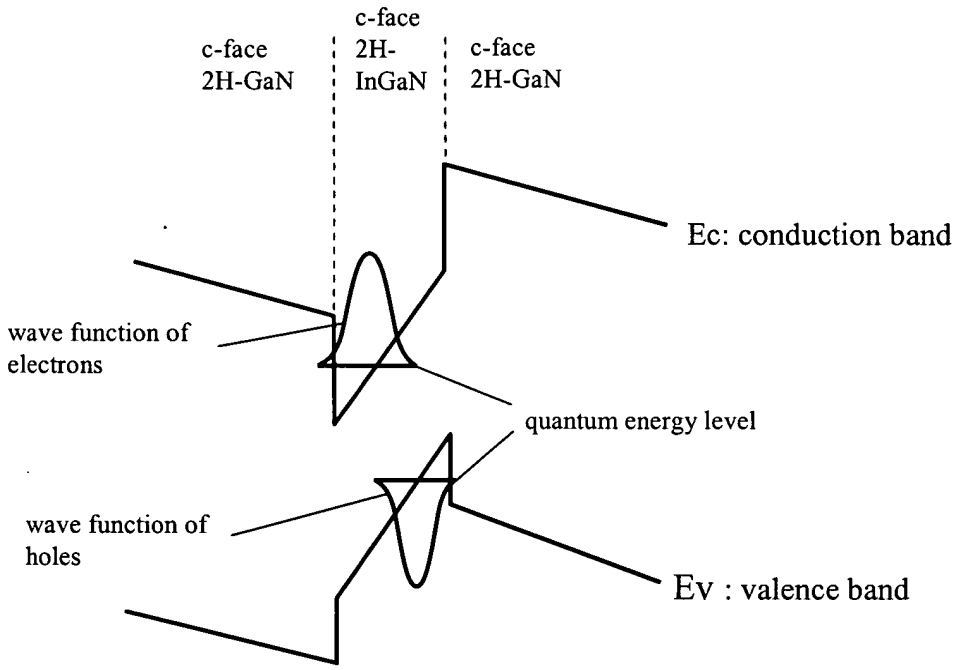


Fig. 5

Schematic band diagram of InGaN/GaN quantum well with 2H-polytype on a c-face substrate

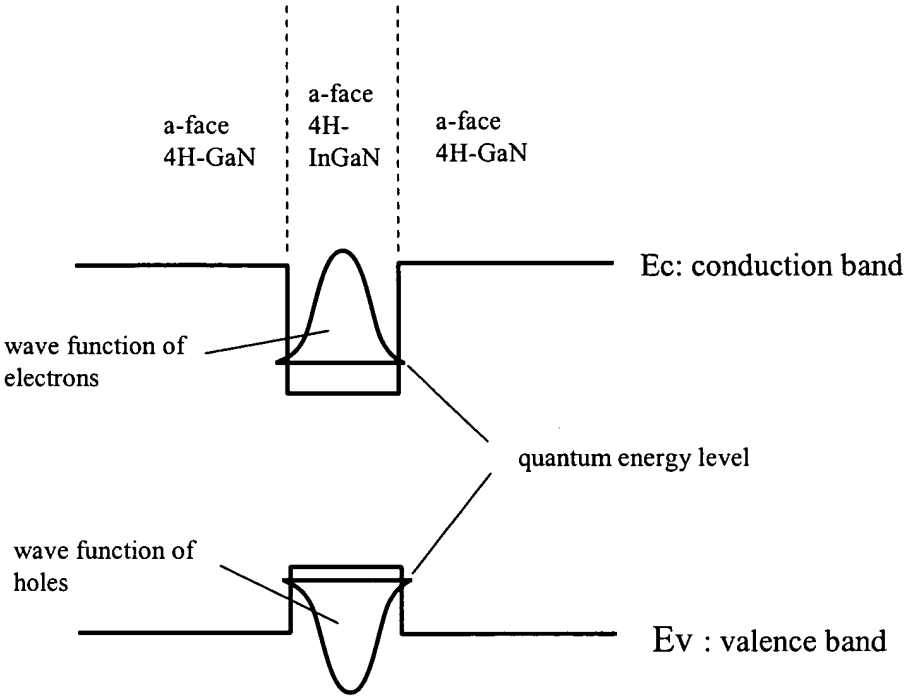
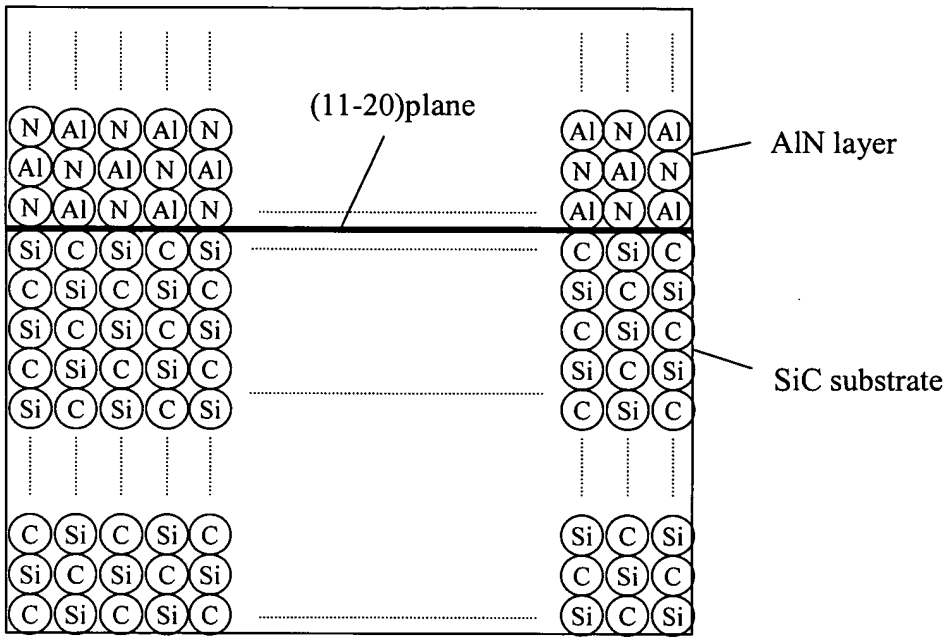


Fig. 6

Schematic band diagram of InGaN/GaN quantum well with 4H-polytype on an a-face substrate

(a)on a non-polar face



(b)on a polar face

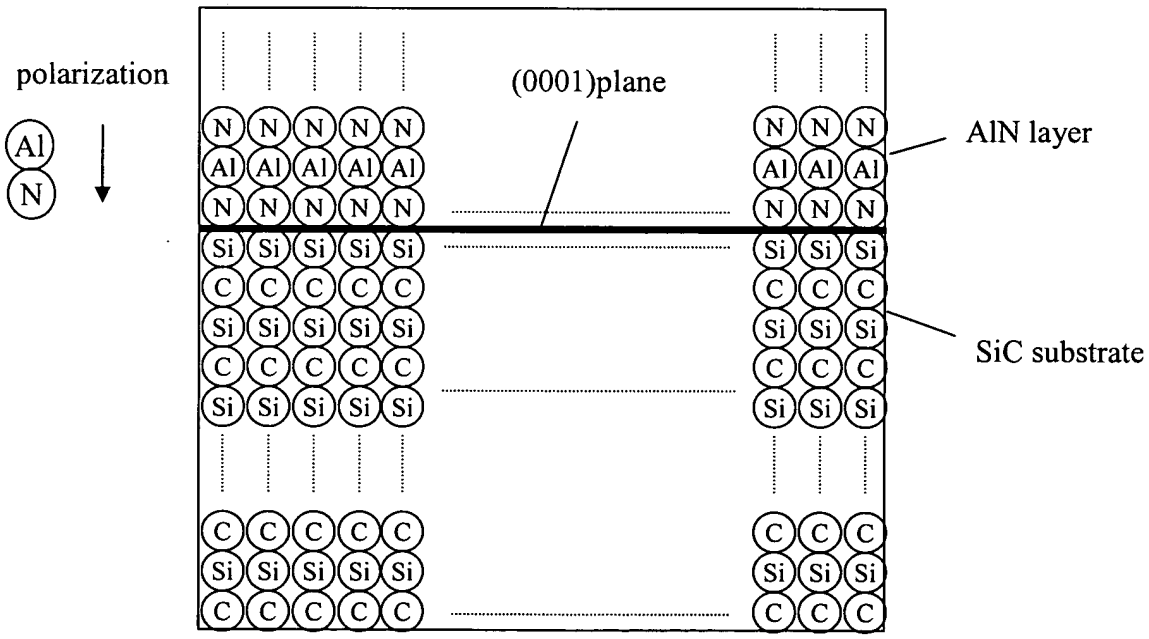


Fig. 7

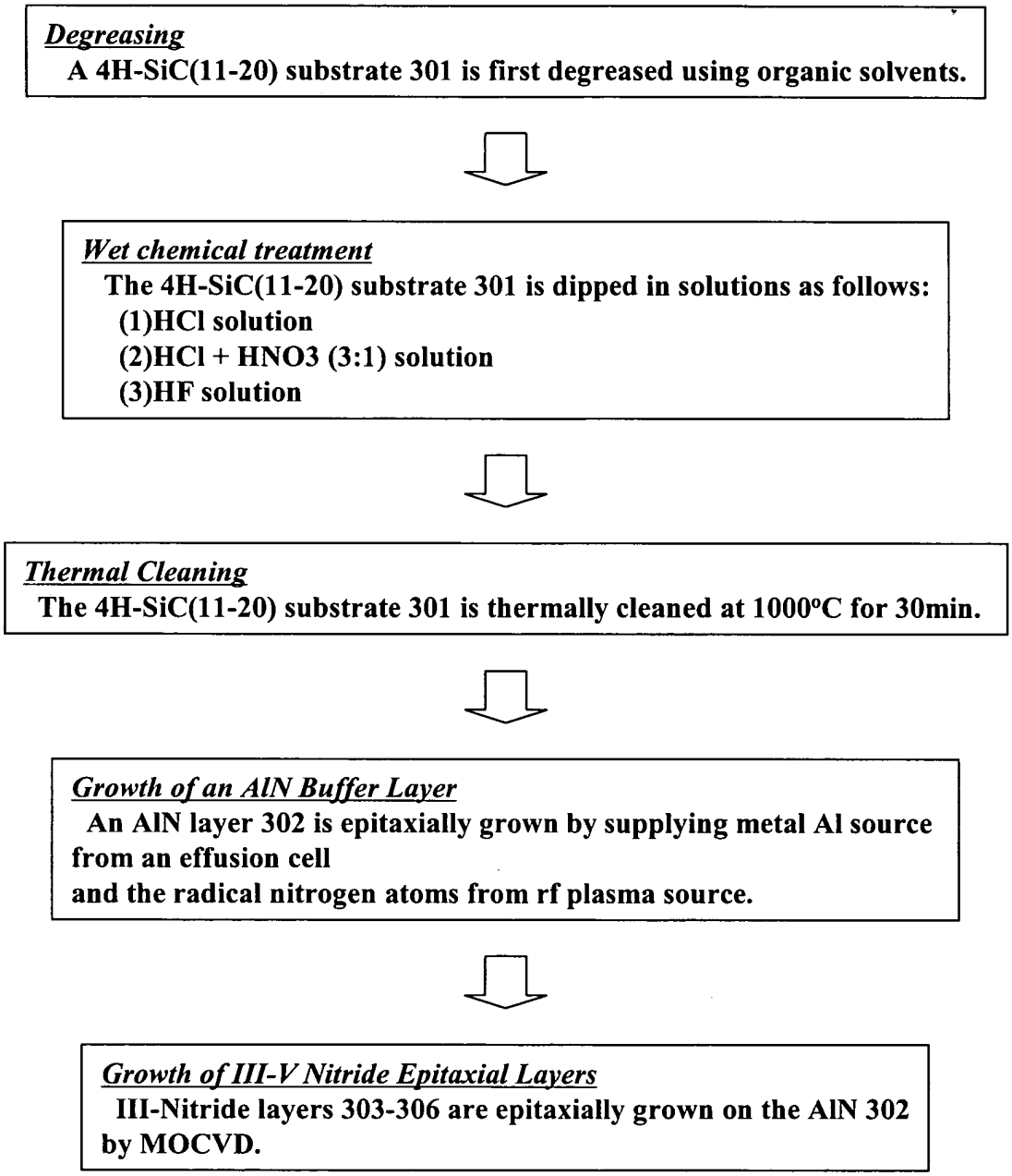

Degreasing
A 4H-SiC(11-20) substrate 301 is first degreased using organic solvents.
Wet chemical treatment
The 4H-SiC(11-20) substrate 301 is dipped in solutions as follows:
(1)HCl solution
(2)HCl + HNO3 (3:1) solution
(3)HF solution
Thermal Cleaning
The 4H-SiC(11-20) substrate 301 is thermally cleaned at 1000°C for 30min.
Growth of an AlN Buffer Layer
An AlN layer 302 is epitaxially grown by supplying metal Al source from an effusion cell
and the radical nitrogen atoms from rf plasma source.
Growth of III-V Nitride Epitaxial Layers
III-Nitride layers 303-306 are epitaxially grown on the AlN 302 by MOCVD.

Fig. 8

<0001> azimuth

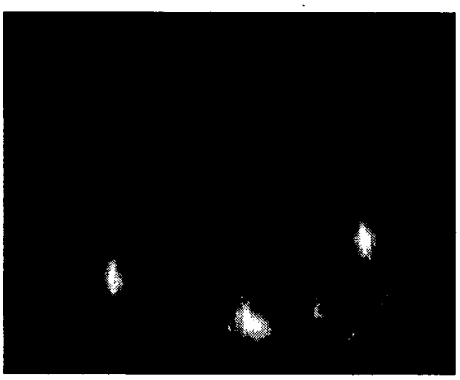
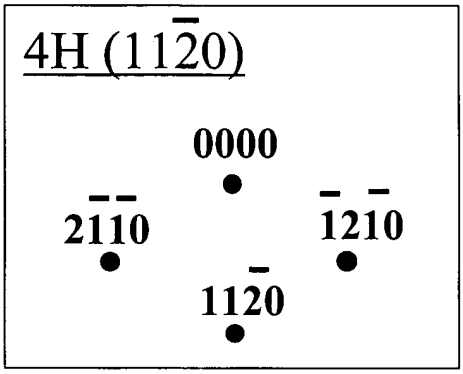
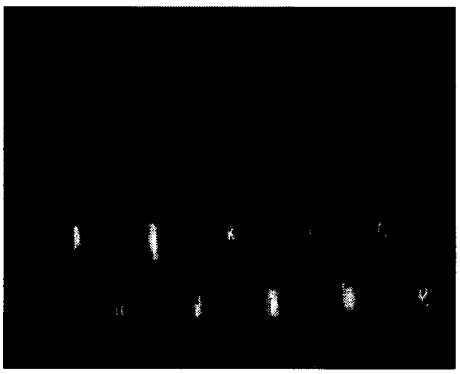
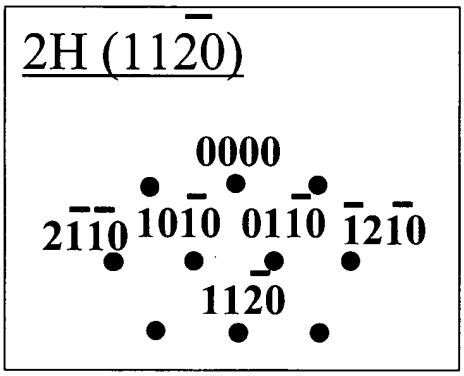
	AlN epitaxial layer	Theoretical diffraction
on 4H-SiC (11$\bar{2}$0)		
on 6H-SiC (11$\bar{2}$0)		

Fig. 9

RHEED patterns of AlN layer on a 4H-SiC(11-20) substrate and on a 6H-SiC(11-20) substrate

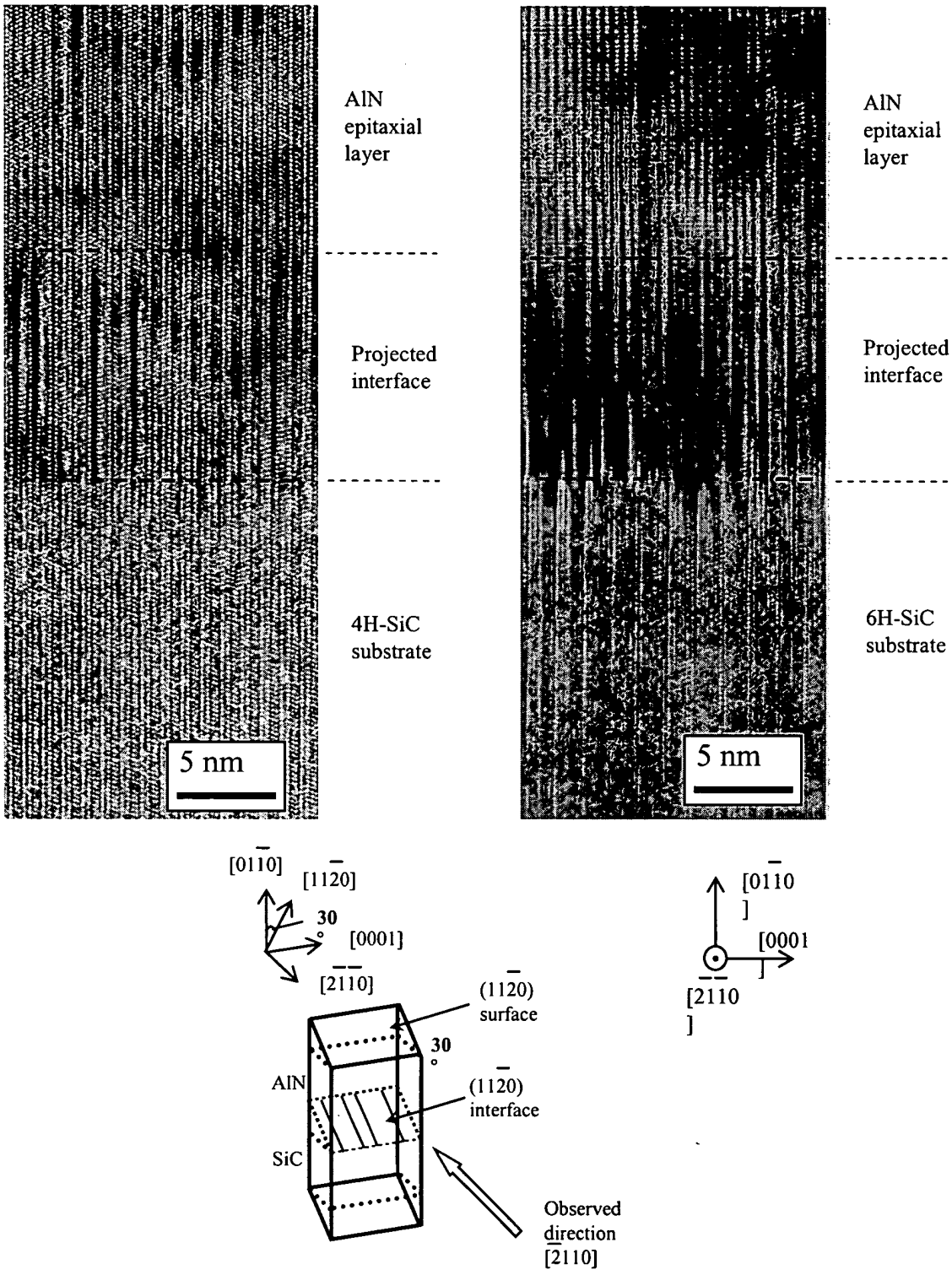


Fig. 10

Lattice images of AlN on 4H-SiC(11-20) and AlN on 6H-SiC(11-20) measured by HRTEM

XRC ($11\bar{2}0$) diffraction

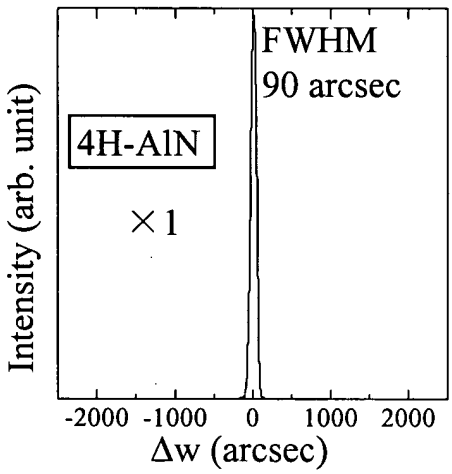
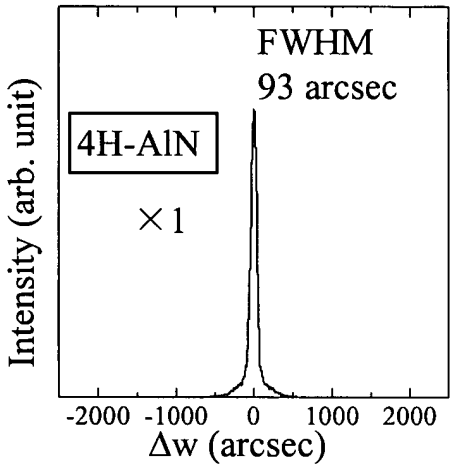
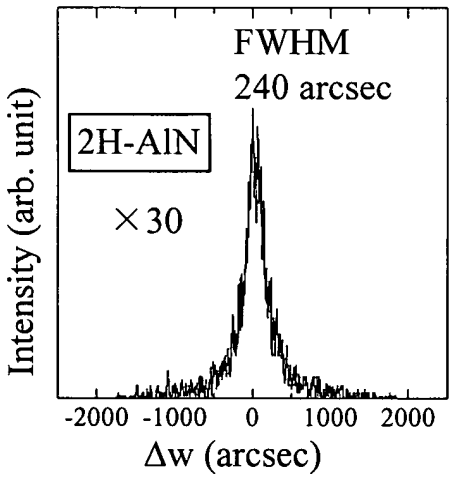
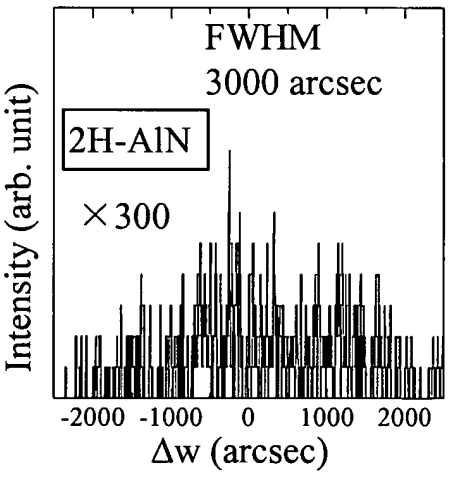
	X-ray // [$1\bar{1}00$]	X-ray ⊥ [$1\bar{1}00$]
on 4H-SiC ($11\bar{2}0$)		
on 6H-SiC ($11\bar{2}0$)		

Fig. 11

X-ray rocking curve profiles on (11-20) diffraction for AlN on 4H-SiC(11-20) and on 6H-SiC(11-20)

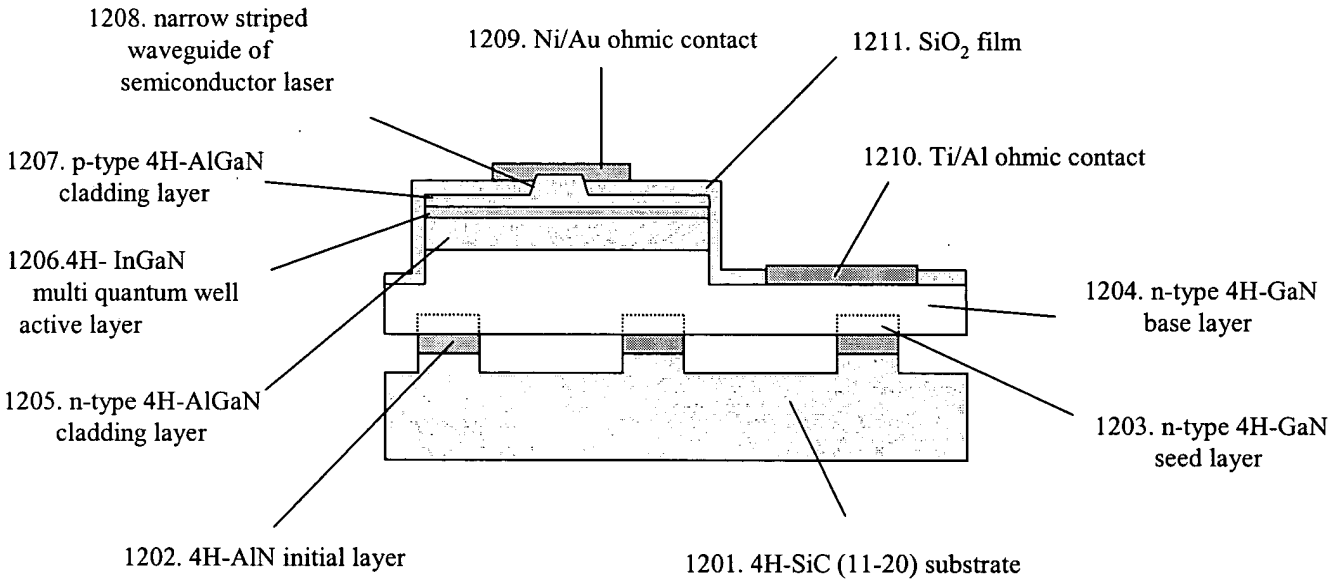
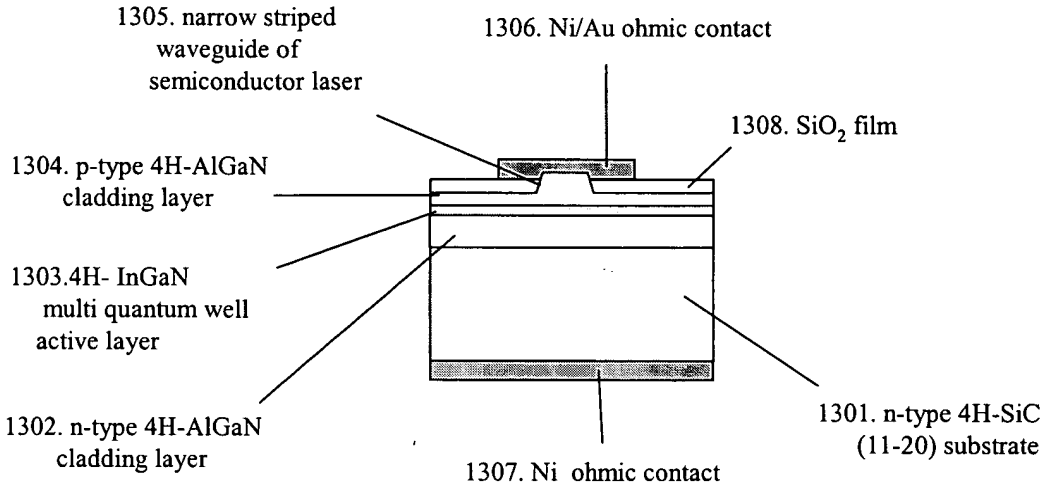
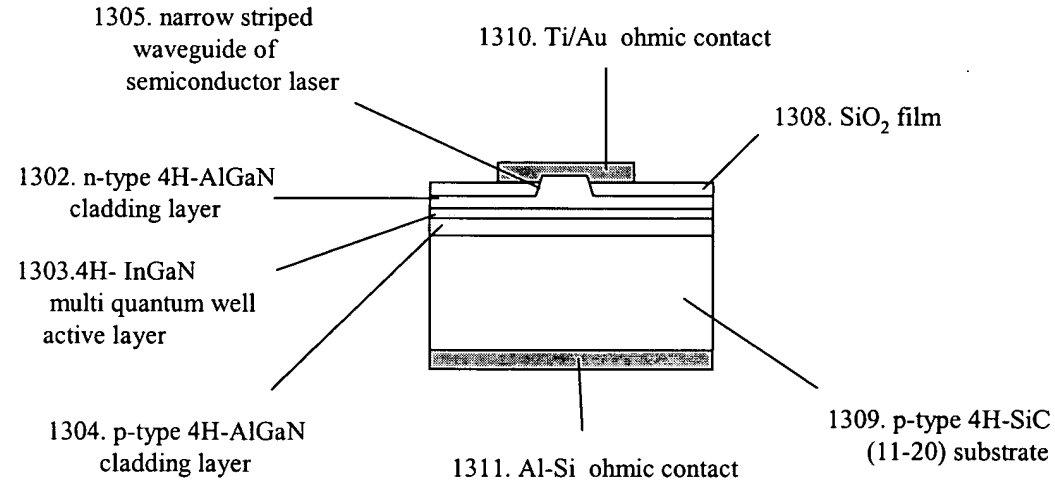


Fig. 12

Cross section of a III-V nitride-based blue-violet seemiconductor laser with 4H-polytype on 4H-AlN/4H-SiC. After the selective etching of GaN/AlN to make narrow stripe on the SiC substrate, laser structure is regrown on it.



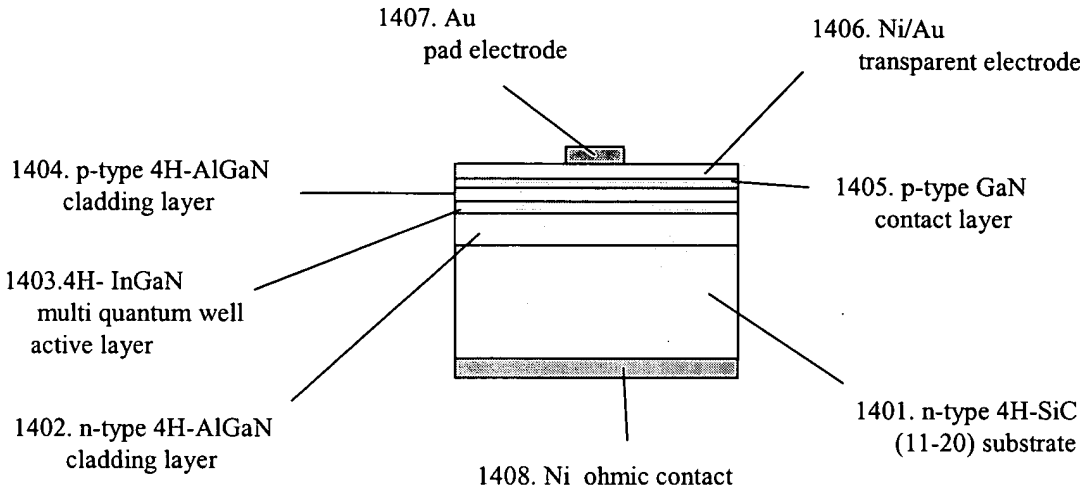
(a) On n-type 4H-SiC(11-20)



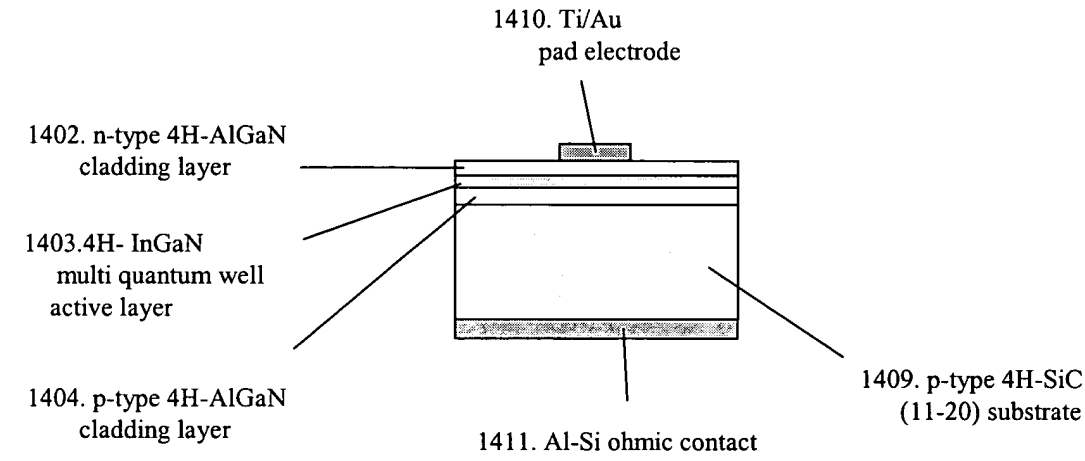
(b) On p-type 4H-SiC(11-20)

Fig. 13

Cross section of a III-V nitride-based blue-violet seemiconductor laser with 4H-polytype on 4H-AlN/4H-SiC. Electrodes are formed on the both sides of the device in which current flows through the conductive substrate and the conductive initial Al(Ga)N layer.



(a) On n-type 4H-SiC(11-20)



(b) On p-type 4H-SiC(11-20)

Fig. 14

Cross section of a III-V nitride-based ultravioler LED with 4H-polytype on 4H-AlN/4H-SiC. Electrodes are formed on the both sides of the device in which current flows through the conductive substrate and the conductive initial Al(Ga)N layer.

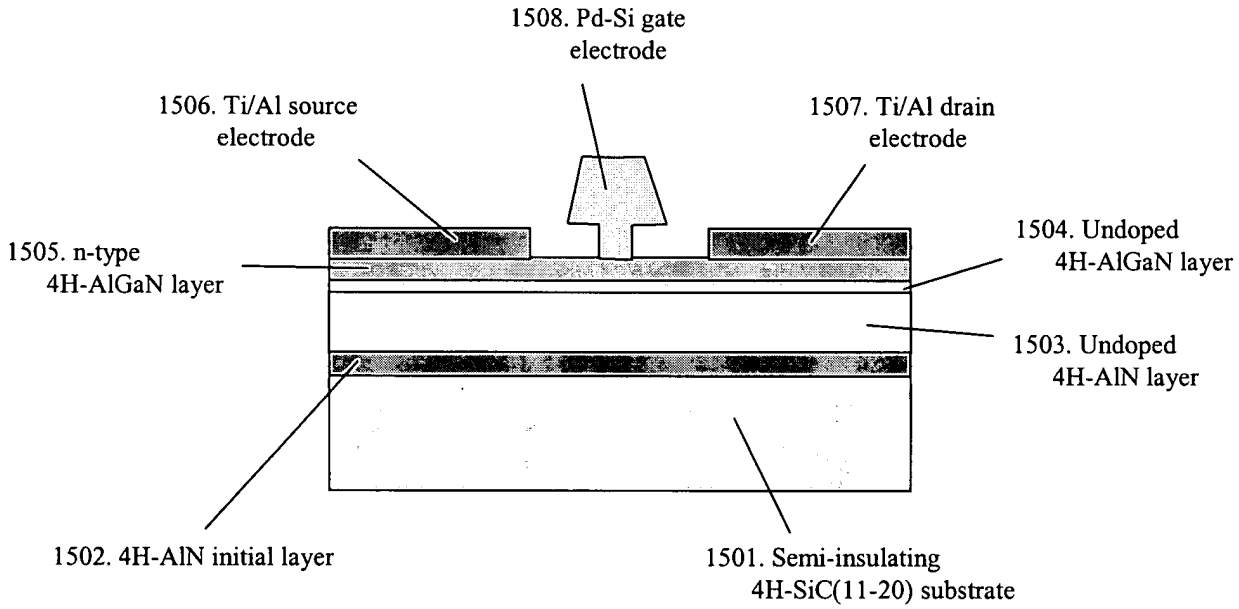


Fig. 15

Cross section of a III-V nitride-based heterostructure transistor with 4H-polytype on 4H-AlN/4H-SiC.